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Unlocking Efficiency: A Comprehensive Approach to Lean In-Plant Logistics

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Abstract: ***This paper presents a structured and systematic approach to implementing lean in-plant logistics complemented by a cost model. It delves deeply into chronic losses and inefficiencies in manufacturing plants, emphasizing issues in material flow, line stoppages, productivity, inventory levels, line-side storage, and kitting, impacting higher costs. Each process phase is meticulously described, along with the inputs derived from them. Organizations benefit from reduced costs, waste elimination, and increased productivity by adopting lean in-plant logistics. The detailed steps outlined in each phase guide practitioners in addressing all aspects of logistics operations within the plant, enabling comprehensive optimization and lean implementation. The proposed system offers numerous advantages, including decreased inventory levels, more efficient line-side inventory management, and lower overall costs.***

Keywords: Lean Manufacturing, In-Plant Logistics, Process Mapping, Material Flow Analysis, Material Handling, Waste Elimination, Labor Efficiency, Space Utilization, Throughput Time, Inventory Management, Equipment Efficiency, Throughput Time

1. Introduction

Logistics in a plant has three major segments: Inbound logistics (From Supplier to Plant), in-plant logistics (From the point of storage to the point of consumption), and Outbound Logistics (Finished goods shipment for delivery). In-plant logistics is an essential aspect of manufacturing operations that involves managing the flow of materials from the point of storage to the manufacturing line (Point of use). In-plant logistics are complex, involving several processes, such as material handling, storage, transport, and sequencing, and several stakeholders are involved. Inefficient in-plant logistics processes can lead to significant losses in excess inventory, non-value-added activity, labor inefficiency, space inefficiency, equipment inefficiency, high usage of forklifts, line stoppages, loss of production leading to lost revenue, increased costs, and operational inefficiencies. Therefore, optimizing in-plant logistics is crucial to reducing costs and increasing efficiency.

2. Methodology

To gain a lean in-plant logistics system, a cost-improvement model is proposed that focuses on:

1) Mapping and studying the in-plant logistics strategies to establish a baseline for losses incurred.
2) Identifying gaps and setting up a baseline for future state development
3) Reducing inventory through production volumes, stock management, optimized stock, redoing safety stock, re-order points, manufacturing scheduling, and line sequencing.
4) Reducing losses by enhancing the indirect-to-direct manpower ratio, growing indirect manpower efficiency, and eliminating non-value-added activity.
5) Reducing space losses through optimizing storage layout, kitting layout, Line side inventory, Material handling equipment utilization, and delivery route optimization.

The below-mentioned breakthrough function evaluation will be used to analyze the outcome.

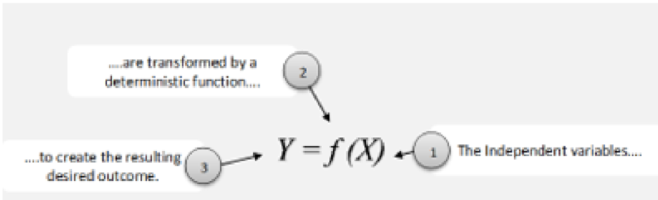


Figure 1: Function Equation

Y = Lean In-Plant logistics system generating optimal results with minimum inventory levels, Optimized material flow, minimized material handling, and short throughput times at a reduced cost.
f = Re-engineer process via. IE project
X1 = Waste Elimination (Transfer of Non-Value-added activities (NVAA) from the point of Consumption to Up-steam processes, eventually towards the Supplier)
X2 = Implement Flow Principle & realize low throughput times
X3 = Inventory reduction
X5 = Reduce inventory discrepancies
X6 = Packaging Standardization (for fasteners & small parts)
X7 = Indirect Manpower & Manpower efficiency
X8 = Reduce Space Loss
X9 = Improve Equipment OEE
X10 = Reduce piece price via. Cube utilization.
X11 = Productivity Improvement – Direct labor optimization
X12 = Training IE & Knowledge transfer via. Standard Procedures documentation

3. Cost Improvement Model

Analyzing, measuring, and eliminating /reducing various Losses:

3.1 Inventory Loss

a) KPI: Inventory
- Unit: Days
- Direction: Lower the Better

b) Focus Areas:
- Production Volumes, Inventory Management (Inventory Fluctuation, Non-Standard Package Units)
- Optimize Safety Stock and Re-order points.
- Production scheduling, Planning effectiveness, Optimized Changeovers

c) Potential Savings:
- Excess Inventory
- Line Side inventory reduction.
- KPI: Customer Service
- Unit: Units Behind
- Direction: Lower the Better

d) Focus Areas:
- Material Management – Missing Direct and Indirect Material
- NVAA – Unnecessary Movement, Waiting, Double Handling and Transport

e) Potential Savings:
- Reduce Inventory discrepancies.
- Reduction in hot part issues
- Reduction in Part issues
- Waste elimination.

3.2 Labor Loss (indirect)

a) KPI: Cost
- Unit: $ (dollars)
- Direction: The lower the better

b) Focus Areas:
- Excess Labor Loss
- Labor Efficiency Loss
- Net Labor Loss

c) Potential Savings:
- Indirect to Direct Manpower ratio
- Indirect Manpower saturation and efficiency improvement
- NVAA

3.3 Space Loss

a) KPI: Necessary Net Space
- Unit: Square Feet (ft2)
- Direction: The lower the better

b) Focus Areas:
- Excess Space Loss (Inventory)
- Excess Space Loss
- Excess Space Loss
- Space Efficiency Loss
- Net Space Loss

c) Potential Savings:
- Storage Layout, process layout, Stores / Warehouse re-organization
- MH Process and handling paths, handling equipment choice
- Inventory Management (Container management, type of container management)

3.4 Equipment Loss

a) KPI: OEE
- Unit: %
- Direction: Higher the better

b) Focus Areas:
- Excess Equipment Loss
- Equipment Effectiveness Loss
- Equipment Net Operating Loss
- Smooth material flow, Material handling plan for each part from the drop zone to the final point of consumption, various logistics process

c) Potential Savings:
- Process and handling paths layout + handling equipment choice (i.e. long and complicated paths because of the layout) + Line Sequencing

3.5 Reduction in forklift use

a) KPI: Fuel/ Energy Saving
- Unit: Energy Cost/ Gas Cost
- Direction: Lower the better

b) Focus Areas:
- Reduction of forklift use

c) Potential Savings:
- Fuel Savings
- Annual Indirect Labor
- Maintenance Savings

3.6 Productivity Improvement

a) KPI: Throughput Time Direct Labor Optimization
- Unit: Minutes
- Direction: The lower the better

b) Focus Areas:
- NVAA reduction
- Part Availability (Uninterrupted production with minimum line stoppage due to material unavailability.)
- Ergonomics
- % Increase in Kitting

c) Potential Savings:
- Units / Month
- Annual direct Labor savings

4. Approach

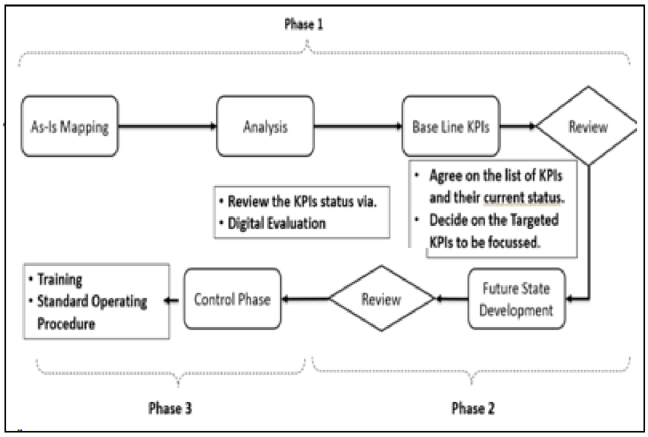


Figure 2: Logistics System Phase-wise approach

Phase 1: Mapping / Analysing Current State Logistic Processes and Define Baseline KPIs
Phase 2: Reengineer Process for Future State Development
Phase 3: Control Phase: Finalize Man assignments and finalize recommendations for Implementation to achieve optimal In-Plant logistics operations.

4.1 Steps to Achieve Lean In-Plant Logistics

Figure 3: Steps to Achieve Lean in Plant Logistics

Phase I: Mapping / Analyzing Current State Logistic Processes

4.1.1 Step 1: PFEP – Part Classification Analysis

In the initial phase of the PFEP (Plan for Every Part) process, we undertake a comprehensive Part Classification Analysis. This involves studying various aspects, such as models, variants, and their respective mix percentages, alongside forecasted volume details and scheduling information. Concurrently, we delve into the Master Bill of Materials (MBOM) to understand commonalities and configurations. Furthermore, we review existing part classification standards and the current PFEP to validate and update the parts classification system as necessary. Our aim is to ensure accuracy and completeness throughout the PFEP. As part of this process, we develop station-wise parts consumption matrices, incorporating the revised parts classification. Any identified gaps are addressed to finalize the PFEP. The outcomes of this stage include a Model Mix matrix, a Unique Part List organized by variant, consumption matrices delineated by operation and model, and comprehensive parts classification data, including supplier packaging details.

4.1.2 Step 2: Material Delivery Analysis

In this process step, we focus on Material Delivery Analysis, building upon the updated PFEP data obtained from Step 1. Our primary objective is to meticulously dissect the current material delivery strategy. This involves scrutinizing various aspects such as parts delivered through Just-In-Time (JIT) or Just-In-Sequence (JIS) methodologies, parts included in kitting processes, those following specific sequencing requirements, and any other relevant strategies such as Minomi. Through this analysis, we comprehensively understand how materials are currently being delivered within the system. By identifying existing gaps and inefficiencies, we lay the groundwork for developing a future state that optimizes material delivery processes. This phase is a baseline for guiding subsequent improvements and enhancements in material delivery efficiency and effectiveness.

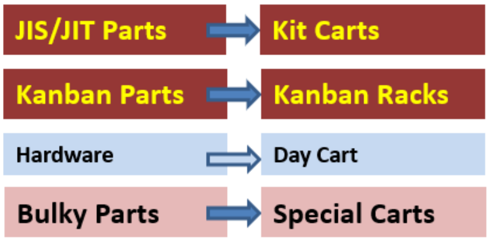


Figure 4: Material Delivery Strategy

4.1.3 Step 3: Layout Analysis

In the third step of our process, we delve into Layout Analysis, utilizing detailed inputs such as storage area specifications, lists of parts in staging areas including their source and destination details, as well as the mode of supply of parts along with quantities, and information on minimum/maximum reorder levels. Our primary focus lies in mapping out the layout and identifying key areas for kitting, sequencing, and storage within the plant. This involves a thorough examination of various storage facilities throughout the plant premises. Through this analysis, we aim to optimize storage facility utilization and enhance the efficiency of material handling processes. Additionally, we conduct location analyses to ensure that storage areas are strategically positioned for maximum operational benefit. The deliverables of this step include insights into layout optimization opportunities and recommendations for improving material flow within the facility.

4.1.4 Step 4: Material Flow Study

We comprehensively study Material Flow and Routes within the manufacturing environment. This involves meticulously mapping the journey of materials from the unloading dock to staging areas and, ultimately, to the manufacturing line. Additionally, we focus on specific material flows, such as painted parts from the paint area to the manufacturing line, to ensure a holistic understanding of the process. Throughout this analysis, we pinpoint any pain points or bottlenecks in the material flow. We systematically document the current material flow routes, including those for bulk materials, fasteners, and kitting sequences, while also gathering material replenishment and flow constraints. Utilizing tools such as spaghetti charts, we gain insights into the complexity and efficiency of material flow patterns. The deliverables from this stage include crucial metrics such as parts delivery intervals, the number of routes, validation of replenishment methodologies against production output, assessment of part travel distances, and quantification of instances of multiple handling of the same part. These insights are a foundation for optimizing material flow and enhancing operational efficiency.

4.1.5 Step 5: Material Replenishment Study

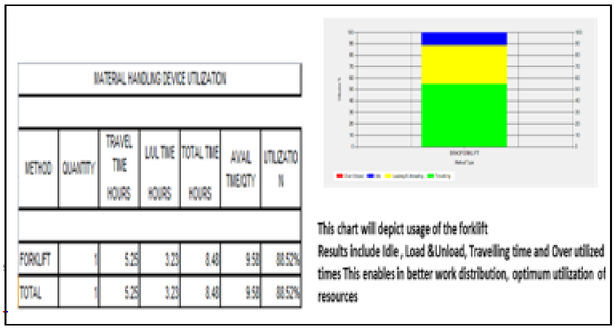
This step starts with a thorough Material Replenishment Study, leveraging inputs from the PFEP data and Steps 2, 3, and 4 outcomes. Our primary objective is to validate inventory levels such as minimum/maximum and reorder points to ensure optimal stock management. We delve into the current ordering methods employed for various parts categories, whether they involve direct-to-dock delivery, in-house storage, or third-party supplier-managed parts. Additionally, we scrutinize the existing information flow related to material replenishment to identify any inefficiencies or bottlenecks. Through this analysis, we aim to pinpoint pain points across different areas of the replenishment process. The deliverables of this step encompass crucial metrics such as line-side and plant inventory levels, details regarding the material replenishment system and techniques utilized, an assessment of the effectiveness of current systems, and the material replenishment frequency categorized by type based on existing standards. These insights serve as a basis for optimizing material replenishment processes and enhancing overall supply chain efficiency.

4.1.6 Step 6: Congestion Analysis

In Step 6, we undertake a comprehensive Congestion Analysis, drawing upon inputs including the current layout, Bill of Materials (BOM), material replenishment strategy, and Material Handling Equipment (MHE) details. Our process involves conducting time studies to assess the replenishment duration for each part from its storage point and traffic analysis across various aisles utilizing flow planner tools. Through these analyses, we aim to identify highly congested aisles and those underutilized within the existing layout. Furthermore, we develop models that facilitate the creation of future what-if scenarios, enabling us to explore potential layout adjustments or operational changes to alleviate congestion and optimize resource utilization. The deliverables from this step provide valuable insights into congestion hotspots and opportunities for improvement, paving the way for enhanced efficiency and productivity within the facility.

4.1.7 Step 7: MHE Utilization Study

Material Handling Equipment (MHE) study focuses on MHE utilization, leveraging inputs such as detailed MHE specifications and assignment charts. Our process entails gathering data on the types and quantities of various MHEs, potentially supplemented by video shooting and time studies if permitted. We also identify constraints related to allocating MHEs to different activities within the facility. Utilizing this information, we map the percentage utilization of various MHEs based on hour meter data and availability records. Additionally, we generate a comprehensive summary of current asset utilization, including Overall Equipment Effectiveness (OEE) metrics. The deliverables from this step provide valuable insights into the current state of MHE utilization, facilitating informed decision-making for future MHE planning scenarios. This includes the development of an MHE matrix that can guide strategic planning and investment in MHE resources to optimize operational efficiency and productivity.



MATERIAL HANDLING DEVICE UTILIZATION						
METHOD	QUANTITY	TRAVEL TIME HOURS	L/UL TIME HOURS	TOTAL TIME HOURS	AVAIL TIME/QTY	UTILIZATION
FORKLIFT	1	5.25	3.23	8.48	9.58	88.52%
TOTAL	1	5.25	3.23	8.48	9.58	88.52%

Figure 5: MHE Utilization

4.1.8 Step 8: In-Direct Labor Study

Indirect resources study is another important aspect that needs to be studied from an efficiency perspective.First, we gather detailed information regarding the indirect labor dedicated, including activity-wise allocation data and skill matrix information for all workers involved. This process may involve video shooting and time studies to capture accurate data. We meticulously map the percentage utilization of labor across various activities, utilizing this insight to prepare labor assignment charts reflecting the current state. The deliverables from this step include a comprehensive labor assignment chart, highlighting the percentage utilization of indirect labor and the Value-Added (VA) to Non-Value-Added (NVA) ratio within logistics operations. Furthermore, we provide insights into labor work balancing, time standards, and skill improvement requirements. Additionally, a list of activities performed by material feeders is compiled, aiding in understanding their role within the process. These deliverables serve as a foundation for optimizing labor utilization, streamlining operations, and identifying opportunities for efficiency improvements.

4.1.9 Step 9: As-is throughput Analysis

Step 9 involves conducting a Current Throughput Analysis through Discrete Event Simulation, using inputs such as layout details, the Bill of Materials (BOM), material replenishment strategies, indirect labor specifics, and Material Handling Equipment (MHE) details. This process starts with collecting and reviewing relevant input data and then developing a simulation base model. The model is then rigorously validated to ensure its accuracy in representing the real-world system. Adjustments and refinements are made to enhance the model's fidelity through a series of iterations and a first-cut review. The Design of Experiments is conducted to explore various scenarios and factors affecting system performance systematically. The deliverables from this analysis include insights into bottleneck areas, system capacity, and potential improvements in throughput, MHE utilization, and resource utilization. Moreover, the analysis identifies specific bottleneck areas within the system and provides recommendations for addressing them, facilitating enhanced operational efficiency and productivity.

Gate Review: Base Line KPI

Table 1: KPIs

Sr. No.	Key Performance Indicators (KPIs)	Base Line Status	% Improvement Target
A.	**Cost Reduction**		
1	Inventory Levels		
2	Indirect Labor Index (Utilization /VA/NVAA)		
3	MHE Utilization (Reduction in MHE)		
4	Cube Utilization		
B.	**Productivity Improvement**		
1	% Line Stoppage due to material nonavailability		
2	Throughput time (order to delivery)		
3	Route Utilization (Balanced Routes)		
4	% of Kitting /Sequencing		
C	**Logistics System Improvement**		
1	Information flow effectiveness		

Phase– II Reengineer Process for Future State Development

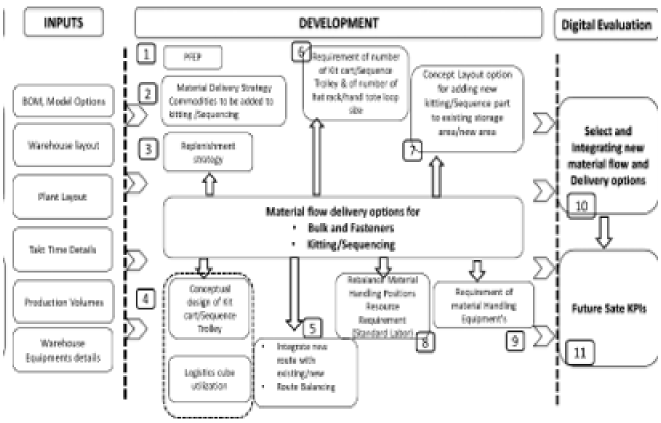


Figure 6: Improvement Process

4.1.10 Step 10: Update PFEP

In Step 10, we leverage the outcomes from the previous phases to finalize the Plan for Every Part (PFEP). Utilizing the data gathered and analyzed in Phase 1, we develop a comprehensive PFEP sheet. This sheet includes master Bill of Materials (BOM) data, material classification information, and optimized container sizes and types tailored to the specific requirements of each part. Additionally, we determine the optimal line-side inventory for each part, establishing safety stock levels and reorder points to ensure smooth production flow. The key deliverables of this step include significant reductions in inventory levels, an increase in inventory turnover rates, enhanced inventory visibility, and the implementation of standardized containers throughout the production process. These outcomes collectively contribute to improved operational efficiency, streamlined material handling processes, and better inventory management practices, ultimately driving overall productivity and performance within the facility.

4.1.11 Step 11: Material Delivery Strategy (Commodities added to kitting/ sequencing)

Building upon the outcomes from previous phases, we meticulously craft a Material Delivery Strategy tailored to the unique requirements of each commodity. Leveraging insights gained from Phase 1, we determine the most optimal delivery method, whether it's Just-In-Time (JIT), Just-In-Sequence (JIS), KANBAN, 2BIN, or other strategies, based on factors such as part consumption patterns, commodity characteristics, and model mix. Additionally, we identify parts with high and low variance to streamline the delivery process further. Through careful analysis, we select the most suitable Material Handling Equipment (MHE) for efficient material replenishment and establish the replenishment frequency based on line-side inventory levels and production demands. The deliverables from this step include an increased percentage of commodities integrated into kitting and sequencing processes, reduced complexity in line-side stock management, enhancements in material replenishment methodologies, improved line-side presentation, decreased line-side inventory levels, and minimized occurrences of part mix-ups, all contributing to heightened operational efficiency and streamlined production processes.

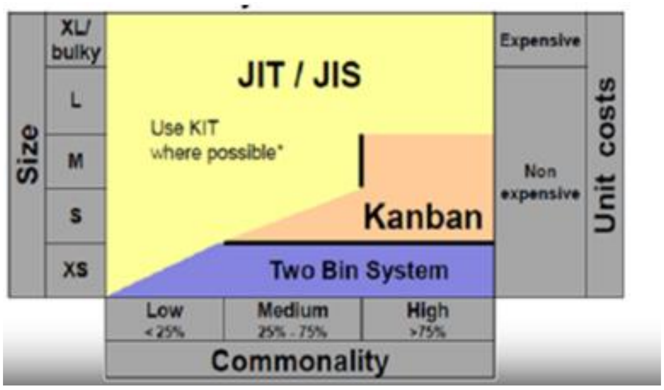


Figure 7: Material Delivery Strategy

4.1.12 Step 12: Replenishment Strategy

Utilizing the insights garnered from the preceding phases, we focus on refining the Replenishment Strategy for optimal efficiency. Drawing from best practices observed across global industries and considering the specific characteristics of each commodity, we shortlist and finalize various material calling systems. These systems may include KANBAN cards, Andon signaling, LED boards, and online triggering mechanisms. By aligning with the PFEP, layout configurations, and replenishment strategies, we ensure that the chosen material calling system facilitates seamless and timely replenishment of materials to the production line. The key deliverables of this step encompass a reduction in line stoppages due to parts shortages, a transition towards process-driven material replenishment rather than relying on individual knowledge, and a decrease in throughput time, all contributing to heightened operational efficiency and smoother production processes.

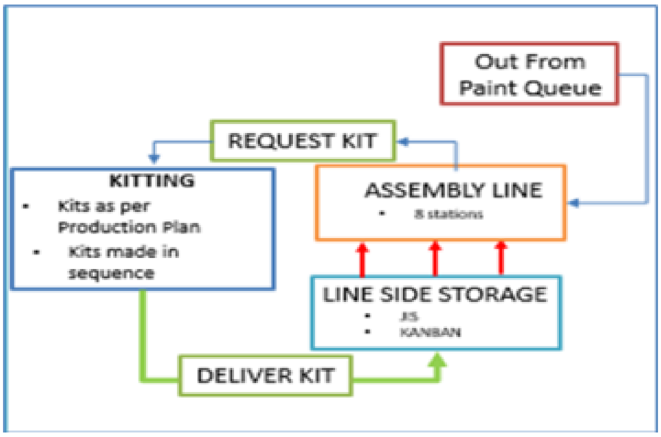


Figure 8: Kit Delivery

4.1.13 Step 13: Conceptual Design of kit cart trolleys

The conceptual design of kit cart trolleys commences with inputs derived from Phase 1 outcomes. The process focuses on designing kit carts or sequence trolleys, emphasizing modularity and optimizing space to effectively accommodate a high density of parts. This involves carefully considering factors such as part size, weight, and frequency of use to ensure an optimum design that maximizes storage capacity while maintaining accessibility. This process's deliverables include reducing line-side complexity stock, enhancing inventory visibility on the line side, achieving an optimum design of carts with high density, and reducing Non-Value-Added Activities (NVAA) in material handling positions. These outcomes collectively contribute to streamlining operations, improving efficiency, and enhancing overall productivity within the production environment.

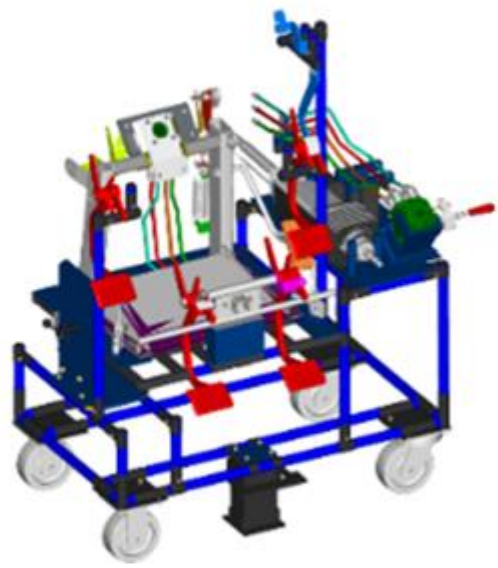


Figure 9: Kit Example

4.1.14 Step 14: Logistics Cube Utilization

The Logistics Cube Utilization process begins with inputs derived from Phase 1 outcomes. The process involves deriving a cube utilization study, which evaluates how efficiently space within transportation vehicles or storage areas is utilized. Additionally, the design of kit carts or sequence trolleys is studied to ensure they are optimized for high-density part storage, maximizing the use of available space. The deliverables of this process include an increase in the percentage of cube utilization, an optimum design for kit carts/sequence trolleys with high-density part storage capabilities, and insights into potential piece price adjustments in logistics due to improved efficiency. Moreover, the determination of the optimum number of vehicles required for transportation is provided, ensuring cost-effective logistics operations. These outcomes aim to enhance space utilization, reduce transportation costs, and improve overall logistics efficiency.

Case Details

Container	Std pack qty	No of pallets	No of parts	% of utilization	Transportation cost per part
40 FT	4	52	208	61%	4.8$ (ASSUMING 1000 $ PER TRIP)
20 FT	4	24	96	66.8%	5.2$ (ASSUMING 1000 $ PER TRIP)

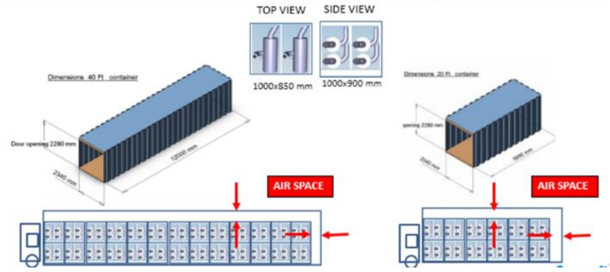


Figure 10: Cube Utilization

4.1.15 Step 15: Integrate new route and route balancing.

Integrating new routes and route balancing begins with inputs derived from Phase 1 outcomes. The process involves redesigning new bulk routes for tuggers and forklifts based on material flow and congestion analysis, focusing on optimizing throughput time. Various routes for material delivery are evaluated to identify the most efficient options. Subsequently, the new route designs are balanced concerning manpower assignment and the number of parts delivered, supported by time studies to ensure optimal efficiency. The deliverables include the optimum route design for tuggers and forklifts, identification of requirements for new routes, reductions in Non-Value-Added (NVA) and indirect labor, increased part turnover, balanced routes to enhance efficiency, and improved utilization of indirect labor capacity. These outcomes collectively aim to streamline operations, minimize delays, and enhance overall logistics and material handling productivity.

4.1.16 Step 16: Number of new kit carts. Racks

Determining the number of new kit carts and racks begins with inputs derived from Phase 1 outcomes. The process involves utilizing discrete event simulation to evaluate the quantities of kit carts, sequence trolleys, hat racks, and totes needed within the operational loop. By simulating various scenarios and considering factors such as production volume, part variety, and material flow dynamics, the optimal numbers of these equipment items are determined. The deliverables include providing the optimum numbers of kit carts, sequence trolleys, hat racks, and totes required to support efficient operations while reducing capital expenditures (CAPEX). This approach ensures that resources are allocated effectively to meet production demands while minimizing costs and enhancing overall operational efficiency.

4.1.17 Step 17: Concept layout and update kit cart position

The outcome from the creation of a concept layout and updating kit cart positions builds upon the insights gained from Phase 1 outcomes. The process begins with the design of a concept layout for the new or existing kitting area, considering factors such as workflow efficiency, material flow, and space utilization. Multiple layout options are developed to explore different configurations and possibilities. These options are then evaluated using quantitative analysis methods to identify the most optimal layout solution. The deliverables include providing an optimum layout design for the new kitting and sequence area, which enhances operational efficiency and minimizes non-value added (NVA) activities for direct and indirect operators. This approach ensures the workspace is organized effectively to streamline processes and maximize productivity.

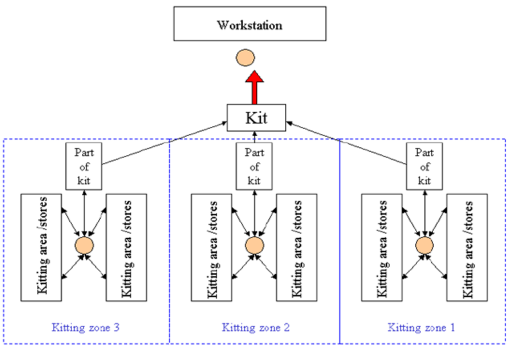


Figure 11 Kit Calling Approaches

4.1.18 Step 18: Rebalance material handling position.

The process of rebalancing material handling positions builds upon insights from Phase 1 outcomes. It begins by analyzing previous data on Value-Added (VA) and Non-Value-Added (NVA) activities to reallocate positions effectively, reducing NVA tasks. Standard times for each activity are determined using PMTS (Predetermined Motion Time System) such as MOST (Maynard Operation Sequence Technique). This enables the calculation of material handling position hours. Subsequently, man assignments are documented in Standards PRO to ensure consistency and efficiency. The deliverables include an increase in the VA/NVA ratio of indirect labor, the balancing of indirect labor tasks, improved utilization of indirect labor resources, and the determination of an optimum headcount, all contributing to enhanced productivity and efficiency within material handling operations.

4.1.19 Step 19: Material Handling Equipment Requirements

Determining Material Handling Equipment (MHE) requirements builds upon insights gained from Phase 1 outcomes. The process begins by defining the types of MHEs to be utilized, considering factors such as delivery route optimization, material replenishment strategy, and layout considerations. This ensures that the selected MHEs are best suited to the operational needs and effectively support the workflow. Subsequently, based on the required number of hours of MHE operation, the number of MHEs needed is calculated to meet operational demands efficiently. The deliverables include providing the optimum quantity and category of MHE required, aligning with operational needs, and enhancing overall efficiency. Additionally, increased utilization of MHEs is achieved, ensuring that resources are utilized effectively to support material handling operations. This approach ensures that the material handling equipment is strategically selected and utilized to optimize workflow and productivity.

4.1.20 Step 20: Discrete Event Simulation of Future State

The future state's Discrete Event Simulation (DES) builds upon insights derived from Phase 1 outcomes. The process entails validating the development of the future state through DES, where logistics operations are meticulously modeled, analyzed, visualized, and optimized using simulation software. This simulation process enables the generation of a comprehensive report based on specific requirements, providing detailed results analysis and offering suggestions for further optimization. Additionally, "what-if" scenarios are explored to assess the potential impact of various changes or interventions. Moreover, due to the simulation outcomes, man assignments are updated to align with the optimized operational processes. Overall, this approach ensures that the future state of logistics operations is thoroughly evaluated and optimized for enhanced efficiency and productivity. from Phase 1

Phase III

4.1.21 Step 21: Labor Stds., Man Assignments, IE Training & SOP Documentation

Finalize Man assignments, finalize recommendations for Implementation, Document and publish the execution framework, and train IE on the process to achieve optimal In-Plant logistics operations.

5. Results

The proposed lean in-plant logistics gadget can have several advantages, which include decreased inventory tiers, decreased line aspect stock, decreased exertions, and area losses, and expanded equipment effectiveness. These benefits can result in lower expenses, expanded operational efficiency, and progressed customer support.

5.1 Phase I Outcome:

The following Key Performance Indicator (KPIs) would be baselined.

Table 2: KPI's Summary

Sr. No.	**Key Performance Indicators (KPIs)**	Base Line Status	% Improvement Target	Future State
A.	**Cost Reduction**			
1	Inventory Levels			
2	Indirect Labor Index (Utilization /VA/NVAA)			
3	MHE Utilization (Reduction in MHE)			
4	Cube Utilization			
B.	**Productivity Improvement**			
1	% Line Stoppage due to material nonavailability			
2	Throughput time (order to delivery)			

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3	Route Utilization (Balanced Routes)				
4	% of Kitting /Sequencing				
C	**Logistics System Improvement**				
1	Information flow effectiveness				

6. Approach Implementation

CAB Line of a leading commercial manufacturer, was not running at its full capacity or efficiency. Several areas of loss were identified, including excess inventory and various forms of waste stemming from non-value-added activities such as waiting, unnecessary movements, multiple handling, transportation inefficiencies, and overproduction.

Furthermore, there were inefficiencies in labor utilization due to indirect manpower saturation and ineffective use of space on the manufacturing floor. Equipment efficiency was also compromised due to suboptimal packaging choices, complex routes, layout issues, and equipment selections, resulting in excessive reliance on forklifts for movements. To address these challenges, the project aims to implement a Lean In-Plant logistics system, minimizing inventory levels, optimizing material flow, reducing material handling, and streamlining throughput times at a lower cost.

The major objectives were defined to introduce the above-mentioned approach and implement lean Plant logistics.

1) Optimized Material Delivery Route (Bulk, fastener, and hand tote & forklift delivery)

- Improved Material flow
- Reduced Material feeding time.
- Increased Material Handling Equipment utilization
- Reduction in forklift equipment
- Route optimization and balancing
- Study feasibility and recommend requirements for additional routes.

2) Reduce the Complexity of Lineside Stock

- Increase in % of Kitting and Sequencing
- Improved parts presentation on the line side using kits.
- Better inventory visibility at the line side
- Identify and execute piece price increases/decreases where possible.
- Rebalance Material handling positions of opportunity.
- Analyze current manpower activities with MOST and rebalance work.
- Non-VALUE-ADDED Activity reduction
- Man assignments.

7. Approach Phases

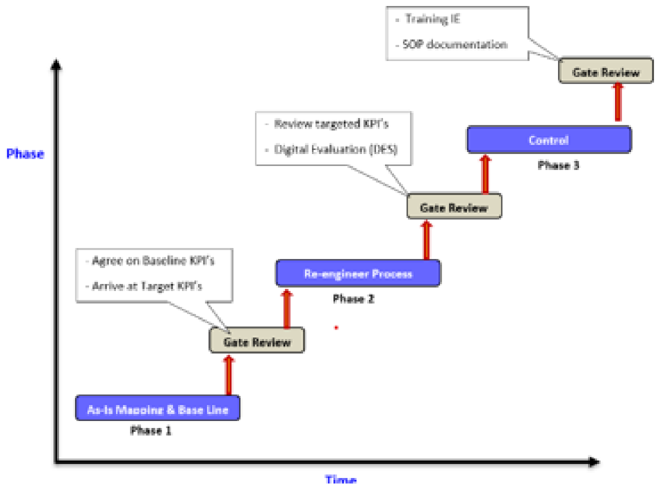

Figure 12: Execution phase

Phase 1: Mapping / Analysing Current State Logistic Processes and Define Baseline KPIs
Phase 2: Reengineer Process for Future State Development
Phase 3: Control Phase: Finalize Man assignments and finalize recommendations for Implementation to achieve optimal In-Plant logistics operations.

8. Results Achieved

Sr. No.	Key Performance Indicators (KPIs)	Base Line Status	Future State
A.	Cost Reduction		
1	Indirect Labor Index (Utilization /VA/NVAA)	76 % (13 man)	86 % (11 man)
2	MHE Utilization (Reduction in MHE)	50 % (11 MHE)	55 % (10 MHE)
3	Line Side Space Utilization	32%	29%
4	Route Utilization (Balanced Routes)	50-55 %	60-65%
5	Cube Utilization		10%
B.	Productivity Improvement		
1	% Line Stoppage due to material nonavailability	In plant Replenishment	Process Design
2	Throughput time (order to delivery)	Average 60-90 min	45-60min
3	% of Kitting /Sequencing	10%	25%

9. Conclusion

The proposed method for implementing lean in-plant logistics offers a comprehensive strategy to optimize in-plant logistics, cut costs, and improve operational efficiency. This approach incorporates a cost development model to gauge its impact. It involves a structured three-phase process of mapping and analyzing current logistics practices, pinpointing areas for enhancement, and establishing a benchmark for future improvements. The detailed steps within each phase serve as a roadmap for practitioners to address every aspect of logistics operations within the plant's confines, facilitating holistic optimization and lean implementation. The proposed system presents several advantages, including reductions in inventory levels, streamlined line-side inventory, and decreased costs.

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